

Radial Profiles of Plasma Electron Characteristics in a Low-Power Arcjet

Douglas A. Codron* and Anuscheh Nawaz**

Abstract

Since 1960, the Arc Jet Complex at NASA Ames Research Center has been a source of long-duration, high-enthalpy flow for materials testing with application to the thermal protection of aerospace vehicle components. From their inception the facilities have played an integral role supporting many of NASA's space flight programs and numerous DoD projects. In recent years advancements in computational fluid dynamics (CFD) have made the resultant models a valuable tool for assessing and predicting performance, however, the inherent limitation of models to compensate for a dissociated, transitionally high temperature nonequilibrated flowfield have made further measurements necessary.

The use of electrostatic probe diagnostics within similarly harsh plasma environments in previous studies have been met with much success. In this study, the use of a single Langmuir probe was implemented to characterize the plasma parameters of interest as they vary radially within a large volume of the plume. Classical Langmuir probe theory was applied to achieve first order estimates of the heavy particle temperature, the ratio T_i/T_e , and the ionization fraction. As expected, both the electron temperature and electron density measurements show a dependence on radial distance from the plume centerline, with electron density profiles showing the largest dependence.

This paper aims to validate and strengthen modeling work conducted at the NASA Ames Research Center by measuring the critical plasma parameters (electron temperature, electron density, and plasma potential) within the arc plume of a subscale arc jet. These parameters are intended to give physical insight into the flow characteristics while providing the necessary boundary conditions to validate full scale simulations.

* Douglas Codron, Mechanical Engineering Intern, Aerothermodynamics Facilities Branch, NASA Ames Research Center, Moffett Field, CA, douglas.a.codron@nasa.gov

** Anuscheh Nawaz, Sierra Lobo Inc., Thermophysics Facilities Branch, NASA Ames Research Center, MS 229-4, Moffett Field, CA, anuscheh.nawaz@nasa.gov